The Effect of Structural Characteristics on Family Planning Program Performance in Côte d'Ivoire and Nigeria

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THE EFFECT OF STRUCTURAL CHARACTERISTICS ON FAMILY PLANNING PROGRAM PERFORMANCE IN COTE D’IVOIRE AND NIGERIA

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Abstract

This paper examines, using Côte d’Ivoire and Nigeria survey data, how structural and demographic factors influence family planning provision and cost. The model explains provision well, but poorly explains cost. We show that size and specialization matter. In both countries, vertical (exclusive family planning) facilities provide significantly more contraception than integrated medical establishments. In Nigeria, larger facilities also offer services at lower average cost. Since vertical facilities tend to be large, they at most incur no higher unit costs than integrated facilities. Model results and cost recovery information point to the relative efficiency of the International Planned Parenthood Federation, which operates large, mostly vertical facilities

Understanding how to lower fertility was an important part of the 1994 International Conference on Population and Development (ICPD). The ICPD calls for dramatic increases in the contraceptive prevalence rates (CPR) in developing countries. The ICPD also specifies the enormous investment in resources required to meet this challenge, and how the financial burden should be shared between developing countries, developed countries, and international donor organizations. However, the ICPD does not describe the exact mechanisms through which to improve and expand reproductive health service delivery programs. In reality, this is because researchers and policy makers have learned few concrete “lessons,” particularly for those parts of the world where fertility levels remain the highest. Planners prescribe little about how to change family planning programs to meet the challenge, since after many years we still have little understanding of how structural characteristics of family planning facilities affect their performance.

Defining “structure” is difficult, but we want to identify the role of characteristics that are to some extent under facility or operating authority control. Structure includes whether facilities are in the public or private sector. Structure also includes whether facilities are “vertically” designed – and only provide a single service such as family planning - or are “integrated” and provide multiple services. Other structural characteristics include the prices that facilities may charge their clients, as well as provider training and other quality-related measures.

Our interest comes at a time of major restructuring in developing country health care services. These include efforts to devolve services away from the central administrative control. Decentralization often involves the complete redesign of management and logistics systems. In addition, the Cairo ICPD calls for creating and strengthening linkages between services in order to increase utilization. Integration is an important policy target for many reproductive health programs.

The debate also continues over the most appropriate form of service provision, and what roles public and private sectors should play. Also, good programs need to be more than efficient: they must also strive to recover costs and become more sustainable. In this paper, we examine using Côte d'Ivoire and Nigeria multi-level survey data, how structural factors influence output and what factors allow demand to be satisfied at low cost. Many of our results agree with the collective wisdom in family planning (FP); while others, including our finding that vertical facilities are more efficient than their integrated counterparts, are both new and surprising.

Previous Literature. Many structural decisions may be historically determined; others may be affected by market competition and demand. Although relatively little research exists in this field, several important studies have helped to shed light on the general outlines of the relationship.

Jensen's research (1996; 1997) explores the interactions between service quality and client fertility. Using Indonesian data, which enables him to link an individual's FP and fertility experience to their contraceptive source, Jensen (1996) shows that women supplied by public clinics are more successful contraceptors. Some aspect of service delivery, rather than client differences, accounted for the success. In the Philippines, Jensen (1997) also finds important quality differences in services offered across various supply channels. Mroz et al. (1999) use Tanzanian data to show that subjective quality perceptions affect contraceptive use more than objective measures of quality or accessibility, such as time and distance to clinics. In a related study, Bollen and Speizer (1998) link subjective perceptions to objective facility aspects, and find that perceived quality is difficult to measure and not highly correlated with objective facility characteristics.

Examining the link between structural practice and use, a study in Nigeria by Feyisetan and Ainsworth (1996) studies the relationship between contraceptive use and FP services. Several structural factors did affect contraceptive use: both longer pharmaceutical operating hours and greater method choice increased usage, and provider fees did not constrain demand. Mwabu, Ainsworth and Nyamete (1993) use Kenyan data to show that higher prices may reduce demand for medical services. Hotchkiss (1998) also examines price effects in Cebu, Philippines. By combining household and facility data, Hotchkiss asks whether the interaction of price with quality creates a positive relationship between price and health service demand. His results suggest that higher prices reduce health care utilization by poorer households, but otherwise have little effect. Simulations suggest that prices may be raised in conjunction with quality improvements, but only if increased revenues are used to improve quality, and only if mechanisms are incorporated to alleviate the affect of price increases on poor households.

Much of the debate over structure has focused on the advantages of integrated versus vertical service delivery. For many reasons, including the belief that positive spillover between FP and other medical services stimulates demand, the critical debate appears to favor integration. Stewart et al. (1999) examine vertical and integrated service delivery in a series of West Africa case studies and with facility survey data from Côte d'Ivoire and Nigeria used in this paper. A single NGO, the International Planned Parenthood Federation (IPPF) and its affiliates, plays a central if not dominant role in FP through vertical programs in all 5 West African nations, including Côte d'Ivoire and Nigeria (see EVALUATION, 1997). In addition, bivariate analyses offered tentative support that vertical facilities more fully utilize their available resources. This study suggests that further research is needed to analyze the relative advantages of various forms of service delivery.

The above studies are important, but answers to the big question – how structure affects performance – will require more surveys that link facility and population characteristics. Without information on the full market demand, it is difficult to study what kinds of service structure matter. Because our study was designed for this, we can link facility data, including cost information, to household data. This may allow us to shed light on structure and performance, including the effect of facility size, operating authority, public versus private, integrated versus vertical, prices, and demand.

Family Planning in Côte d'Ivoire and Nigeria. Family planning services are not widely used in either Côte d'Ivoire or Nigeria: about 4 percent of reproductive aged women currently use modern contraception (estimates from 1994 Côte d'Ivoire demographic and health survey (DHS) and 1990 Nigeria DHS). These low levels may reflect the governments' attitude towards FP. In Côte d'Ivoire, the government was unofficially pro-natalist until 1990, and Nigeria did not adopt a population policy until 1989.

Family Planning arrived in Côte d'Ivoire in 1979 with an NGO called AIBEF (Association Ivoirienne pour le Bien-Etre Familial, Ivorian Association for Family Well-Being), which is affiliated with the IPPF. AIBEF became operational in 1986 with a vertical facility. Other international organizations have entered into FP in Côte d'Ivoire independently or in collaboration with AIBEF. The government of Côte d'Ivoire has been slow to change its pro-natalist orientation. Although some FP activities exist at government health facilities, the vast majority offer none. Those that do offer services typically do so within integrated environments and with the assistance of AIBEF or UNFPA.

Nigerian FP is far more complex. Family planning and other health and educational responsibilities are distributed between the three governmental levels: federal, state and local. Within each level, there are both vertical and integrated facilities. A variety of private organizations also provide FP. In particular, the IPPF affiliate in Nigeria, PPFN, is an important FP promoter and supplier, although they do not dominate the supply as in Côte d'Ivoire. Overall, relatively few facilities in Nigeria are vertical, but there are enough to separately estimate the vertical and operating authority effects in the model. See Tables 1a and 1b for facility type percentages in each country.

Survey Design. Both surveys followed a similar sampling plan. Each country had a recent DHS survey, and the DHS clusters were used as linking devices for the facility survey design. For selected DHS clusters, facilities in the immediate area of that cluster were included in the sample. The original sampling plan was to take a census the health facilities in the proximity of a random sample of DHS clusters. Because the DHS is a population based random sample, this procedure would provide a country-representative random sample of "market areas" for health facilities. Logistic and other practical concerns required some modification of this sampling methodology for each of the survey countries.

In Nigeria, five states (Anambra, Kebbi, Lagos, Osun, and Plateau) with 18% of the national populations were included in the survey. Four of the states were selected randomly from USAID focus states, while the fifth was chosen from the non-focus states. Within each state, a random DHS cluster was selected, and all facilities listed in the health facility census for the Local Government Authority (LGA) that contained that cluster were included. Additional DHS clusters were randomly selected until the survey reached the target number of health facilities in each state. The Nigerian sample can only be considered random for the 5 states included in the study; the sample achieves representativeness of the market of services available in these states. Since the states themselves were randomly chosen for the purposes of this survey, we believe that this offers a reasonable picture of the entire country.

In Côte d'Ivoire, FP services were only reported to exist in 4 of the 10 regions of the country; therefore, the survey was limited to these four relatively rich regions (South, North Central, West Central, and North). A procedure similar to the one described in Nigeria was followed, with the sub-prefecture being the local level of government employed to define the geographic region around the DHS cluster. Due to the interest in vertical clinics, the DHS clusters closest to the 7 clinics of AIBEF were automatically selected for inclusion in the sample.

The facility surveys were conducted in Côte d'Ivoire and Nigeria in the late spring and early summer of 1995. A total of 100 facilities were surveyed in Côte d'Ivoire and 463 in Nigeria. Only facilities that provided FP services and complete data to construct the necessary variables are included in our analysis. This reduces the Côte d'Ivoire sample to 31 and the Nigerian sample to 261 facilities. Tables 1a and 1b present the breakdown by facility type.

Principal Measures. This section explains our main dependent variables: output and cost. In addition, we describe how we use operational structure and authority, and how we use information from the DHS to construct a measure of the market area for each facility.

Output and Cost. Output refers to the ability to convert resources into potential clients or an underlying amount of "protection" provided by a facility over time. We specify the "output" or service provision of a facility by Couple Years of Protection (CYP), which is the most common approach to standardizing contraceptive choices. This method uses weights to transform the facility client and disbursement statistics into a measure of how many total years of protection each method provides a typical couple practicing FP (Table 2). The weights adjust for duration, effectiveness, age of users, consistency, misreporting, non-contraceptive use and overlapping coverage (Stover et al 1996).

Cost is simply the labor, contraceptive, and equipment cost per CYP provided, and is used as a proxy for efficient resource use. The largest component is labor cost, which we estimated using both clinical and non-clinical FP data obtained from the scenario analysis survey module. We calculated contraceptive and equipment costs by assigning a price to the supply disbursement survey totals using IPPF price lists. See Appendix for details.

Structure and Authority. FP systems are organized in a number of different ways, which we refer to as structure. This covers many dimensions: at a gross level, these differences are embodied in the operating authority (e.g. public, NGO) of the provision system. We measure these through simple dummy variables in the model. However, we can also measure operational and policy decisions. Note that prior decisions that depend on other variables in the model, for example deciding that all facilities of a type will in urban areas, have important implications for measuring structure. These include pricing strategies and vertical versus integrated service provision.

In Côte d’Ivoire, FP services are provided by three distinct organizations. AIBEF provides FP in vertical clinics, the government provides FP in a small number of integrated facilities, and a group of government clinics participated in a UNFPA program that provides equipment, supplies, training, technical assistance, and policy consultancy. Thus in Côte d’Ivoire the comparison is vertical <u>and</u> NGO vs. integrated <u>and</u> public. In the statistical model, we chose to call the variable AIBEF, but we could have called the variable VERTICAL.

In Nigeria, some facilities within each authority (including IPPF affiliated clinics) are structured as integrated facilities while others are vertically organized, so we can measure each effect directly. However, the original decision to organize a facility in a particular way probably differs by operating authority, and also may be related to other variables in our analysis, such as population demographics. The reason why a government facility is “vertical” probably differs from the IPPF decision process.

Market Area. Each facility has a population of potential clients from which it must draw to produce output, which we refer to as the catchment population. The size and characteristics of this population are a primary determinant of the output produced at each facility. Practical restrictions require us to define the catchment for each facility according to political or demographic boundaries which may differ from the relevant population served. These areas proxy for an economist's version of geographic markets. In Côte d'Ivoire, we used a sub-prefecture; in Nigeria we used a DHS cluster, or the area around a point that DHS defined for the purposes of their data collection. The population for a sub-prefecture in Côte d'Ivoire is much larger than the corresponding DHS cluster population in Nigeria (Table 2), but note that we were able to associate facilities with a DHS cluster even if they were not located within that cluster, so the "market" in the two countries are of comparable size.

The ability of a facility to generate CYPs from a given catchment population also depends on alternative supply sources. There is a clear difference in the level of potential competition in Côte d'Ivoire and Nigeria. In Côte d'Ivoire, only eight of 21 sub-prefectures contained multiple FP facilities. In contrast, all markets in Nigeria were served by multiple facilities. The model section below explains how we measure the effect of multiple facilities within a given area.

MODEL

Here we present the system of equations for each country. One of the basic characteristics of any productive system is the possible influence that provider size plays on the provision process. Economies of scale may exist in this case, so the model we choose must allow for that possibility. In our case, we clearly expect the number of CYPs provided by the facility to influence operating cost, so simple regression methods may produce biased results.

We turn to a two-equation system. Equation (1) relates CYP provision to the demographic and structural factors discussed above. Equation (2) relates the cost per CYP to demographic, structural, and the endogenous provision of CYP. Even under this endogeneity assumption, we may not need to do more than run a separate OLS regression on each structural equation. The two issues that influence this decision are (1) whether endogeneity is valid, and (2) whether the decrease in bias from a simultaneous system is overwhelmed by the increase in the variance of the results which stems from the estimation method. We present test statistics for each country that address these issues.

(1) $CYP_{ij} = f(X_j, Structure^1_{ij})$

--CYP_{ij} the monthly CYPs provided at clinic i in market area j

--X_j a vector of exogenous variables that affect the demand for FP in market area j

--$Structure^1_{ij}$ a factor vector that describe the structure of clinic i.

(2) $AC[CYP_{ij}]= g[CYP_{ij}, Structure^2_{ij}]$

-- $AC[CYP_{ij}]$ the average cost per CYP in clinic i.

-- $Structure^2_{ij}$ a factor vector that describes the cost in clinic i. The two Structure vectors will contain many of the same variables.

We assume this specific functional form for the equilibrium output equation (1):

$$CYP_{i,j} = \alpha_0 \, Pop_{i,j}^{\left(\beta_0 + \sum_{n=1}^{N} \beta_{n,j} X_{n,j} + \sum_{m=1}^{M} \beta_{m,i} Structure_{m,i}\right)} Price_i^{\gamma_1} \, RelPrice_i^{\gamma_2} \tag{3a}$$

where $Pop_{i,j}$ is the population faced by facility i in market j, $Price_i$ is the price charged for pills by facility i, and $RelPrice_i$ is the relative price of pills to IUDs at facility i.

We will explain the pricing variables in more detail below. After taking logs on both sides, the equation to be estimated becomes

$$\begin{aligned} \log(CYP_{i,j}) &= \log \alpha_0 + \beta_0 \log(Pop_{i,j}) \\ &+ \sum_{n=1}^{N} \beta_{n,j} X_{n,j} \log(Pop_{i,j}) + \sum_{m=1}^{M} \beta_{m,i} Structure_{m,i} \log(Pop_{i,j}) \\ &+ \gamma_1 \log(Price_i) + \gamma_2 \log(RelPrice_i) \end{aligned} \tag{3b}$$

This is a reduced form production function, including both prices and external determinants of demand and technology, and follows directly from the available survey data. Even though the data do not contain the enough detail to estimate a standard production function, there are theoretical reasons why we use this specification. The basic assumption of production functions, that the facility tries to maximize revenue or profit, would be a heroic one to make in this instance. In addition, input markets are far from perfectly efficient, and input prices are either fixed in the case of labor, unknown, or free in the case of contraceptive supplies and equipment. However, we do have good measures of the underlying determinants of service use, and a summary of how the facility is run, both of which affect the output in a reduced form setting.

Our logged interacted form, which is similar to a Cobb-Douglas or Trans-Log functional form if the log of population is considered a normal input variable, provides two useful things. First, the main output determinants of a non-profit maximizing facility are the characteristics of the population being served and the characteristics of the supply environment. We assume that most effects will depend on the size of the market itself. A relatively more efficient provision strategy or a higher proportion of educated women should allow for more output, all other things equal, in a larger market. For the facility authority variables in particular, this interpretation seems to fit the data well.

The second is an elasticity interpretation to the coefficients. Since exogenous structural and demographic variables enter the estimation equation as an interaction with logged market population, they are interpreted as increments to the population elasticity coefficient $\beta_{0.}$ This is both convenient for explaining effects, and is actually a less restrictive assumption than imposing a global linear relationship. Elasticity is the percent change in one variable given an arbitrarily small (usually stated as 1%) change in another variable. The only assumption made is that the relationship is linear in a small neighborhood around the actual values of the dependent variable, not linear along any arbitrary value of the dependent variable, as in the linear reduced form setting. The total elasticity of market population on equilibrium CYP output is:

(4) $$\eta = \beta_0 + \sum_{n=1}^{N} \beta_{n,j} X_{n,j} + \sum_{m=1}^{M} \beta_{m,i} Structure_{m,i}$$

where η is the percentage change in facility CYP provision per percent change in the population of the market area, given the values of the demographic and structural variable of the facility.

The structure of the cost function is simple, since we assume that the market area in which the facility operates only affects cost through the level of CYP provided at the facility.

(5) $$CYPCOST_{i,j} = \beta_0 + \beta_1 \log(CYP)_{i,j} + \sum_{m=1}^{M} \beta_{m,i} Structure_{m,i}$$

Empirically this is convenient, since it allows for many identification restrictions. Also this is clearly how our cost components operate in these two countries. All but perhaps completely private facilities pay staff according to national pay scales, receive contraceptives through international donations, and purchase or requisition equipment at a central source. Any cost difference will be due to the labor hiring mix, a decision captured by authority variables, or utilization practice, which is summarized by both authority dummies and differences in output. We test all identification restrictions and the overall performance of our estimation procedures in the results section below.

Estimation method. We use simple two-stage least squares to estimate the parameters. Identification restrictions are required in order to consistently estimate the parameters. The identification restrictions include $Structure_{ij}$ vector differences, X_j exclusions in the cost equation, and the functional forms. Substantively, our main identification restriction is that the demographic or demand approximating variables will not affect the cost directly, but will affect the cost of CYP provision only through their influence of the number of CYPs provided. Among the available techniques, we believe the simplicity of 2SLS and its reasonably good performance when compared to more complicated techniques (see Bollen 1996 for a good analysis of 2SLS and other structural techniques) make it the ideal procedure for our circumstances.

Although the output of FP services does depend on the demand in the surrounding market area, it is not a classical supply and demand relationship. Prices are not used to clear the market and are therefore not endogenous to our production process. Practically, this means that price does not have a postulated effect. Ceteris paribus, higher prices lower the amount demanded of a particular good. However, if all relatively efficient and high quality facilities were to charge a relatively high price that was nevertheless affordable, then prices could actually have a positive relationship to output through quality signaling.

The other important assumption is that FP method mix is exogenous to production strategy. The difficulties of estimating a multiple output, multiple input production process with limited data aside, the formulation employed here will attenuate potential bias. We measure the latent protection provided by each method, not the amount of any particular type of contraception. A decision to promote any contraceptive method should not introduce bias, if that strategy is consistent within a facility type. However, this will make the relationship more noisy, since any strategy that we do not model specifically will be captured with the general facility type dummy variables. For example, if all LGA facilities in Nigeria promote IUD use, we will not be able to separate the efficiency gains of promoting this relatively high CYP generating procedure from the general LGA effect. This is a very important point and one that we return to often: IUD promotion is a definite characteristic of the LGA regime, but it will *not* be reflected in a pure dummy variable LGA effect if we measure IUD promotion directly. However, if certain single facilities promote any one contraceptive type, and that is why their CYP numbers are high, this is a classic omitted variable problem and could produce bias. We found no evidence of this type of method promotion; however, in the case of Nigeria, IUD is promoted in general, and we do attempt to measure this promotion through differential price effects.

Program Placement. What we believe to be the most serious potential problem in this formulation, and indeed in most attempts to measure the effects of a service offered for a specific purpose, is that the service is not and should not be offered at random. In fact, evidence for precisely this kind of placement was found in other African countries (Angeles et al 1998). The medical sector may only offer FP or other types of medical services where the perceived demand is sufficient, where the service is most needed, or for some other unknown reason. In the absence of any specific or known placement strategy, these tendencies could cause bias in more than one way (Gertler and Molyneaux 1994; Montgomery and Casterline 1993).

In Côte d'Ivoire, FP service placement seems driven by operating authority. Non-UNFPA government facilities appear to offer FP with little or no area preference, within the limited areas where FP is offered at all. UNFPA facilities decided to sponsor sub-prefectures served by multiple facilities. Finally, AIBEF appears to place facilities in urban areas with high service demand. As long as we include urban and multiple facility indicators in the regressions, we violate no statistical assumptions; however, it will be more difficult to separate the effects of clinic structure from those that stem from being located in an urban area or one served by more than one facility. In practice, this will cause the pure structural dummy to understate the AIBEF and UNFPA effects. Unfortunately, we have too few observations to test this type of "problem" parametrically for Côte d'Ivoire.

Such is not the case for Nigeria, where we formulate a test of whether urban and other possible demographic variables are used to place facilities or programs. Another potentially more serious placement problem is that an operating authority may use an unknown criteria to place FP.

If this criteria or strategy is not captured in the demographic indicators, for example if it is overtly political, then the problem becomes one of classic endogeneity. Technically, a facility structure right hand side variable would be correlated with an unknown exogenous variable that would be subsumed into the common error term, which would cause biased and inconsistent results. The Nigeria section presents some specific methods for testing this possibility.

Results. We present the complete results for each country separately. The first equation explains the equilibrium output generated at each clinic. The most obvious assumption here is that increased CYP provision is the program goal. A program designed to increase access in rural areas may not have the same atomistic output goals that we assume. The observed output is the result of the nature of the "market" being served by the health facility, the health facility characteristics, and the availability of alternative service sources.

The "structure" factors are included in the analysis in two ways. First, all factors that affect a clinic's ability to successfully attract clients may be completely embodied in the operating authority identity. The government or a specific NGO will make decisions that affect the resources available to the clinic, it will set policies and supervision procedures that affect service quality, and it will make decisions with respect to fees charged. We also examine, to the extent measured, the effects of these factors individually. Below, we estimate the output equation in three different specifications to explore these alternative, while we estimate the cost equation with single specification for all models. The results both within and between the specifications are useful in uncovering the true effects of structure and practice.

Côte d'Ivoire -Table 3

Model 1. In the first model, only operating authority structure dummies are included. By not including demographic variables, except for population, we give the facility credit for being in a naturally high or low propensity FP area. If a facility is able to place itself in these areas deliberately, this may not be a bad assumption.

The regression shows that AIBEF facilities provide significantly more CYPs. The UNFPA effect is positive, but insignificant and of small magnitude. Of the eight sub-prefectures served by multiple facilities, four have multiple UNFPA sponsored clinics. All else being equal, CYP production at a clinic would be smaller if a geographic region was served by multiple clinics, so a variable measuring clinic competition (1/number of clinics in the sub-prefecture) is included in all models. It is a “structural” variable, since the UNFPA organizational decision is a structural one, and it is a “market” variable since it describes the competitive environment. In the Nigeria analysis below, we only include this type of variable after the Model 1.

The competition variable has the expected sign (positive), is statistically significant, and is of fairly large magnitude. We will not explain in detail the incremental elasticity effect for every result, but here we trace the results for one variable, and for subsequent results we give the relative effect on actual production implied by the coefficients. The pure population contribution (the coefficient) to elasticity is 1.2, meaning a 1% increase in market population would lead to a 1.2% increase in CYP provision. This is not a large population increase in countries with greater than 2% population growth annually. Add in the incremental effect of an extra .2 from the competition variable, and the elasticity increases to 1.4. At the average facility provision levels of 159 CYPs per month in Côte d’ Ivoire, this implies an extra 3.2 CYPs provided monthly, which we believe is a substantial effect.

When we exclude the competition variable, the UNFPA coefficient sign changes to negative and is significant. The likely interpretation of these UNFPA results in model 1 is not that UNFPA clinics are particularly inefficient in generating CYPs from a given population, but rather that the per clinic output is small because they serve a given area with multiple small clinics. If the regressions are on markets rather than facilities, markets served by AIBEF and those served by UNFPA have higher CYP provision than markets served by government facilities not associated with UNFPA.

Model 2. When we include only demographic and economic variables, Côte d'Ivoire data show a strong positive relationship between sub-prefecture population and clinic output. The data also suggest that clinic output is significantly higher if the clinic serves an urban locale. Note also the 45% decrease in pure population elasticity, which is expected since population in model 1 probably captures other demographics now included directly. Increasing the number of clinics in the sub-prefecture significantly reduces the CYP output per clinic. Because of limited degrees of freedom, only average children ever born and the percent of mothers with primary education are included as demographic descriptors. Though both have the expected sign, neither approaches significance. The average price of FP (proxied by the price of a CYP of pills) has a negative effect on CYP output, as does the price of IUD relative to pills. Both of these effects are what economic theory would predict, but neither is statistically significant. The coefficient on the price of IUD relative to pills is large (negative price elasticity at 35% of pure population elasticity) and is close to significance. If the analysis is done on the sub-prefecture rather than facility level, the relative price of IUD becomes significant and is of similar magnitude.

Model 3. When we include everything in the CYP regressions, relatively little changes, which indicates that these separate effects are fairly strong and that pure structure is not being subsumed into demographic effects through an unknown placement strategy. Sub-prefecture population remains a significant determinant of clinic level CYP provision and is again slightly smaller than the other two models, as expected. Given population and its characteristics, AIBEF clinics generate significantly higher CYPs through what we consider a pure management effect. The effect is relatively small when compared to the coefficient on the competition variable, although it still increases the population elasticity by about 10% and therefore could have a large cumulative effect over time. The coefficients on both price variables remain negative and insignificant.

The results of the three estimations tell a fairly consistent story. At the very grossest level of analysis (Model 1), should the population of the prefecture increase by one percent, equilibrium output at a government operated facility would increase by 1.34%. If the facility were operated by AIBEF, the increase would be 1.44%. If the facility were UNFPA sponsored, the increase would be 1.26%. When we add demographics to the model, the incremental elasticity AIBEF effect falls from about .21 to about .15. Since 75% of the AIBEF effect remains in the dummy variable in the full model, most of AIBEF effect seems to be managerial. AIBEF made the following choices: it chose to place its facilities only in urban areas with a more educated population; it chose to charge fees that are on average 10% higher than government facilities and 5 times higher than UNFPA facilities; and it chose to serve sub-prefectures where it is the only supplier of FP services. Given these choices, they still generate more CYPs from their catchment population.

However, what if the AIBEF coefficient was insignificant in the full model? Would that mean there is nothing special about their clinics? Certainly not. Many other measures were controlled by AIBEF, such as pricing decisions and, at the time the facility opened, how much competition it would face. The importance of this analysis does not hinge simply on the magnitude and significance on the dummy variable, but on the entire decision process of the facility operating authority. We discuss this in greater detail in the policy section.

Cost. In Table 4, the second stage regressions poorly explain cost variation. In all models, the AIBEF coefficient is negative, suggesting that given output levels, AIBEF clinics have a lower cost per CYP. These results are only significant, at the 90% confidence level, in model 2, and imply that AIBEF provides CYPs at about 25% of the cost of other facilities through a pure management effect - an interesting result even though it does not quite meet standard significance. The effect of predicted output on cost is positive and never approaches significance, suggesting little evidence of economies of scale. The coefficient on the UNFPA variable is negative but never significant. Figure 1 plots CYP output and cost. Most of the facilities are clustered at very low levels of CYP generation, and the small clinics show extreme variation in average cost. With each clinic counting equally in the regression, the estimation results contain a substantial amount of noise.

Table 5 presents a variety of diagnostic statistics which test the appropriateness and strength of the model. Given the poor explanatory power of the second stage, these statistics also tell a somewhat weak story. This is in contrast to the R-squared values of the first stage, which are consistently high and imply that a predicted endogenous variable would not contribute much noise into the system. The first row of the table presents an endogeneity test for each first-stage specification. We ran the second stage with the actual number of CYPs and the predicted residual from the first stage included in the regression. Failure to reject a coefficient of zero on the predicted residuals would be evidence that the errors are correlated and the two-stage system is appropriate. In none of the first stage specifications does the t-test approach significance. This is not an argument that CYP provision is exogenous. This simply says that the reason why endogenous variables violate the assumptions of ordinary least squares, their correlation with the error, is not present and therefore OLS may be consistent.

Since the instruments are so well predicted, the coefficients on the actual number of CYPs in the cost equations are little different than the coefficients on the predicted values from the original specifications, and neither is significant in any of the models. No other coefficients are affected much in the OLS cost equation specifications. The AIBEF coefficients tend to become slightly more significant, but never reach the 10% level in either model 1 or 3, where they were insignificant before the adjustment.

The second row is an over-identification test of the validity of the exclusion restrictions. We add all but one of the excluded variables back into the second stage (the entire vector would be perfectly collinear with predicted CYPs) and perform a simple F-test. Rejecting a joint zero coefficient vector implies that the model is mis-specified. We never fail to reject the joint zero hypothesis, which indicates that our population interactions and functional form assumptions are valid.

The final row presents the concentration parameter, following Mariano (1982) and Bollen, Guilkey, and Mroz (1995). The parameter measures the cost in precision of a two-stage regression versus the bias inherent in using OLS in the second stage. The numerator of this parameter is the residual sum of squares of a regression where the dependent variable is the predicted CYPs constructed from only the first stage vector excluded from the second stage, and the independent variables are the second stage included vector. It measures, like the F-test above, the quality of the exclusion restrictions. The denominator is the estimated variance of the pure error term from the first equation. In Monte Carlo results, Guilkey et al (1992) find that a parameter value in the mid 70s or higher indicates that two-stage methods are preferable. In none of the first-stage specifications does the parameter approach this level. This is due to the high correlation between the excluded and included vectors, even though a high first-stage R-squared implies a low residual and a high concentration parameter. This points to the relatively high cost of this two-stage model, although the OLS second stage results perform no better than their 2SLS counterparts. We claim no results for Côte d’Ivoire affected by this aspect of functional form.

Nigeria

Our functional form performs considerably better in Nigeria. Table 6 compares CYPs provided across facility types. There is little trend in operating authority, except for PPFN affiliates, which produce an order of magnitude more CYPs than any other facility type. Other authorities tend to operate facilities that are the same size, or at least provide roughly equivalent numbers of CYPs. Vertical structures do provide more CYPs per facility on average. The average number of CYPs produced in Nigeria is 22, or only about 14% of the average level in Côte d'Ivoire. However, the median facility size is similar.

We separate the analysis into the same three specifications as in Côte d'Ivoire. The larger number of observations allow us to add more demographic variables to correct for demand effects and compensate for any unknown facility placement, which may depend on demographics.

Model 1. Table 8 Column 1 presents the two-stage model with only the authority variable population interactions. Only the vertical dummy has a small, positive, and significant effect on CYP provision. The PPFN facilities provide a marginally insignificant increase in CYPs, but this effect disappears in later models. This is extremely surprising, in that they do produce huge numbers of CYPs, but this is completely captured by the vertical and demand variables. To the extent that PPFN controls these factors, they do point to something that PPFN does well. Interacting operating authority with the vertical variables had little to no effect in either stage of any model. The apparent vertical organization advantage is similar across operation authority. Base population elasticity is not significant in this model.

In the Table 9, Column 1 cost equation, the predicted CYPs (along with almost everything) is insignificant, which is expected given the relatively poor measurement in the provision equation. The urban coefficient is negative and significant. We discuss poor cost estimation below in more detail.

Table 10 column 1 presents the Model 1 diagnostic statistics. We reject the hypothesis of a zero coefficient on the residuals, implying endogeneity, and our identification restrictions seem valid according to the F-test. However, due to extremely high correlation between the excluded and included vectors in the second stage (R-squared in regression = .99) , the concentration parameter is extremely low. Although we exclude many variables, our identification restrictions boil down to a single functional form assumption: population matters in the first stage but not in the second. This builds in a high correlation and points to the appropriateness of fuller models.

Model 2. Table 8, Column 2 presents the CYP equation with only demographic variables. This assumes that either operating authority and organization do not matter systematically, or that these differences can be completely captured in placement decisions dependent on demographic characteristics. The demographic variable would therefore also capture facility differences. We also include the log of the CYP pill price, and the price ratio of a CYP of IUD to pills. IUD is the method most promoted in Nigeria, and has by far the lowest relative charged price per CYP of any method offered (see Table 7). In addition to the Côte d'Ivoire demographics, we include infant mortality and the percent of women that completed primary and secondary education. Many variables are significant, but they are equally likely to have a perverse sign as an expected sign. The competition variable has an unexpected, large, and consistent effect. Facilities that are relatively near other facilities actually provide more CYPs. This is probably capturing clustering and urbanization not captured in the urban dummy. The CYP pill price coefficient is strongly negative, but this disappears in the full model. The price ratio coefficient is insignificant. In the cost equation, predicted CYPs are insignificant, and urban is significant and negative.

The Table 10, column 2, diagnostic results are quite interesting. The endogeneity effect is even more significant than in the first model, and the F-test still points to specification validity although the p-value is smaller. The concentration parameter here is much higher and well within the identified range of implying that the two-stage correction is valid. We went from a single functional form assumption implying identification to having two dissimilar variable sets explaining the two model stages. This low correlation implies a large numerator and therefore a large parameter. In this case the only thing we prove is that we correctly estimate almost zero effects as opposed to incorrectly estimating almost zero effects.

Model 3. Column 3 in Tables 8 and 9 present the full model. Once again, neither the pure interactive dummy variables nor the demographic indicators completely capture the facility "effect." A consistent result across models is that vertical facilities provide slightly more CYPs. The consistent facility results also suggest that we capture most of the placement choice and that unknown effects are not present. Another interesting result is that pricing variables are insignificant when we add facility dummies, which implies that pricing is driven by operating authority, not by the facility itself. The competition effect is also still present and large. Finally, when we measure both demographic and authority effects, we see clear evidence of economies of scale in CYP provision. The coefficient on the predicted CYPs in the cost equation is strongly negative. The average cost of a CYP is $6.91, so the scale effect implies a 15% drop in operating cost. However, regardless of specification, we only explain about 5-6% of the variability in cost. This "non-result" is as hard to explain by chance as a classic significant coefficient, and points to the diverse Nigeria health sector, with no authority or practice clearly superior in terms of cost.

The first two diagnostic measures in Table 10, column 3 imply a well specified and endogenous model, but the concentration parameter reflects the relatively large cost of two stages. Since we now claim an economies of scale result dependent on the endogenous specification, it is important to re-run the model using the actual number of CYPs in the cost equation to test our conclusions.

The predictive power increases dramatically (R-sq=.25 vs .06), but that is expected, since the two-stage precision loss is precisely the cause of the low concentration parameter. The coefficient on CYP increases from -1.00 to -1.51, a 50% increase, and is still significant (p-value=.00 vs predicted coefficient p-value=.04). The urban coefficient, which is just insignificant (p=.14), drops a bit and is still insignificant. The vertical coefficient increases (1.07 vs .78) and is now significant and positive in the OLS specification. This is new evidence that vertical facilities might have higher cost, but two facts argue against this. First, the coefficient on vertical in the cost equation is quite unstable and rarely significant; it is actually negative under the first model specification. Second, the average vertical facility provides double the CYPs as the average integrated facility. The coefficient on the predicted log of CYPs is the exact change in cost resulting from a one unit change (i.e. CYPs increasing by the base of the log, or by a factor of around 2.72) in the variable, so doubling CYP production implies about a .7 unit change in log CYPs. In this case, the average unit cost in vertical facilities barely differs from the integrated case (1.51*(0.7)=1.05 decrease due to doubling of provision - 1.07 increase of being a vertical facility). These results are still biased: the concentration parameter implies that the precision loss from using a two-stage model is more of a problem than the bias created by using OLS. This has implications for the significance of the vertical coefficient, but our economies of scale results were strong in the two-stage specification and are still strong now.

Models 4 and 5. The final two models attempt to capture any unknown placement decisions through fixed effects. Although the ideal solution may be to model the facility placement directly (Angeles et al 1998) or construct a first difference across a panel to cancel out time invariant placement strategies, the cross sectional data and relatively few observations preclude these options. However, including area dummy variables in the equation performs reasonably well, compared to more complicated methods. The disadvantages are that including many variables uses up degrees of freedom, with the resultant precision loss, and in this case the logical area definition is the DHS cluster. We also have a group of demographic indicators calculated at the cluster level, which led to collinearity problems. Nevertheless, the consistency of the following results is encouraging.

In model 4 (Tables 11 and 12, Column 1), we add four dummies representing Nigerian states. Excluded is Lagos, the commercial capital, so it is not surprising that every location coefficient is negative. The coefficients are mostly significant in the provision equation and insignificant in the cost equation. This implies that to the extent operating authorities placed facilities in these states, previous results were biased. However, this adjustment did not affect the findings from model 3. Vertical still has a small significant effect, competition still strangely increases CYP provision, scale economies still exist, and cost is still poorly measured. The urban effect falls but is still significant, and the log of the population is now barely significant.

It is very interesting to note the values of pure population elasticity (.56) and the vertical coefficient (0.06) in probably our best specified model. Vertical (AIBEF before) provision has almost exactly the same 10% effect on population elasticity as in Côte d'Ivoire. Again, over time this effect is not small. Taken together, the area dummies seem to serve as a finer measure of demographics, which allows urban and population variables to measure their effect more accurately.

In model 5, we include a dummy for all but one of the DHS clusters. Because of the collinearity problems, seven of the 29 parameters were dropped, which casts doubt on the appropriateness of this strategy. But again, none of the major conclusions change; in fact, economies of scale are larger. The consistency of results is perhaps the strongest evidence that we capture something real, and not a spurious correlation due to the endogenous placement.

The diagnostic measures (Table 13) are disappointing. Only the F-test shows any evidence supporting these specifications. However, in models 4 and 5 we fail to reject the hypothesis of joint zero coefficients for fixed effects in the cost equation. Including a large number of spurious variables will inflate the correlation between the excluded and included vectors in the cost equation and decrease the parameter value. When the fixed effects variable are excluded from the cost equation (Table 14), the diagnostic statistics look much better. They pass the endogeneity and F-tests, and the concentration parameters are comfortably above the middle 70s threshold. The coefficient on predicted CYPs is -.80 in the modified model 4 and -1.01 in the modified model 5.

6. DISCUSSION AND CONCLUSION

Programs to improve developing country health care continue to search for policy silver bullets. Unfortunately, relatively little work has been done to understand the complicated interrelationships between program structure, operating environment, and performance.

We have attempted to take a first step toward modeling these relationships. We attempt to define structure in the broadest sense, by examining the effect of operating authority, demographics, markets, and the interaction between them. It is in precisely these interactions that trends emerge, and without the ability to break down facility and market characteristics into smaller components, we would be unable to pinpoint how things happen and why. Which of our results is relevant for policy of course depends on the policy question. If purely increasing output or decreasing cost is a desirable outcome, what do our results say about two broad policy silver bullet candidates: cost sharing and recovery, and integration.

Sustainability. As donor funding declines, cost recovery remains a critical component of any attempt to increase health program self-sufficiency. The ICPD meeting explicitly called for countries to share service provision costs. To address this, we calculated (Table 15) the median percentage of direct operating costs per CYP covered by client payments. Facilities cover a very small percentage of operating costs. In Côte d'Ivoire, the median rates run from 2.5 to 11.8 percent. In Nigeria, the figures are substantially better; the lowest level is 16.9 percent (higher than the best in Côte d'Ivoire) and the highest is 190 percent. Not surprisingly, private facilities are more sustainable, since they need to recover a substantial portion of costs to stay in business. However, the vast gap between private facilities and others suggests they may be targeting different client types. In both Côte d'Ivoire and Nigeria (excluding private), facilities affiliated with IPPF appear to be the most sustainable. AIBEF appear to operate at the lowest cost and highest volume in Côte d'Ivoire, and PPFN targets large populations in Nigeria. In Nigeria there is no difference in cost recovery across vertical and integrated facilities.

We combine this recovery information with our model results to see if we can say anything about the overall performance. In Côte d'Ivoire, the mean cost of a CYP is \$12.90, and AIBEF facilities, even though the relationship is noisy, appear to reduce that cost by around \$9.00. Even though this result is not quite statistically significant, it provides fairly strong support for expanding AIBEF investment. AIBEF also produces significantly more output, so we have a good case to make for the superiority of the AIBEF approach. Why is AIBEF more effective? The effect is more than their ability to bring in clients, since economies of scale appear insignificant. It is possible that part of AIBEF's advantage is due to their vertical design. This is consistent with prior utilization analysis in Côte d'Ivoire (Stewart et al., 1999).

In Nigeria there is no clear operating authority effect, but that by no means indicates it does not exist. Economies of scale are important, so cost savings arise from simply being large, regardless of authority. PPFN facilities are much more than 2.72 times larger than the next largest type, so a significant \$1.00 to \$1.50 cost drop per CYP from \$6.90 should be achievable. PPFN facilities do nothing special managerially -- they simply have located in the "right" area and have chosen a good size to be: very large. Since PPFN clinics recover a higher percentage of their costs as well, investment in PPFN clinics seems an eminently reasonable choice. Perhaps we could capture both scale and smaller but important vertical effects in our “ideal” sustainable program by investing in PPFN clinics and requiring them to be vertically organized.

Integration. Support for integrating FP with other health services has become almost universal. The logic for integration is compelling: linking FP with other valued health services will increase the spillover demand for FP. Also, sharing across multiple activities may allow facilities to more fully utilize their resources and avoid costly redundancies. The results of our study provide no support for either proposition. In our estimations, vertical facilities consistently provide more CYPs, and do so at no higher cost.

We began this paper by talking in terms of a prescription: how should the facility be organized to accomplish FP policy? The most appropriate conclusion is that it depends on the disease. We believe that if a program goal coincides with what we measure, increasing CYP provision or lowering CYP cost, this analysis offers concrete recommendations. It is precisely the depth of the data available in these two countries that sheds light on the complex interaction between environment, authority, and structure, but it is also this depth that compels us to warn the potential user of this information that both “programs” and “performance” need to be defined with care.

Table 1a: Structural Characteristics of Cote D'Ivoire Health Facilities

Variable	Description	Cote D'Ivoire (N=31) mean (standard error)
AIBEF	=1 if facility is run by AIBEF and is therefore vertically organized	0.226 (0.425)
UNFPA	=1 if facility is government run with the assistance of UNFPA	0.355 (0.486)

Table 1b: Structural Characteristics of Nigeria Health Facilities

Variable	Description	Nigeria (N=261) mean (standard error)
VERTICAL	=1 if facility is vertically organized	0.110 (0.313)
FEDERAL	=1 if Federal government facility	0.034 (0.182)
STATE	=1 if State government facility	0.117 (0.323)
LOCAL	=1 if Local government facility	0.583 (0.494)
PPFN	=1 if Facility run by the Planned Parenthood Federation of Nigeria	0.011 (0.106)
PRIVATE	=1 if Facility privately operated	0.250 (0.434)
MISSION	=1 if Facility run by a Mission	0.004 (0.062)

Table 2: Dependent Variables and Demographic Characteristics of Nigeria and Cote D'Ivoire

Variable	Description	Cote D'Ivoire (N=31) mean (se)	Nigeria (N=261) mean (se)
TOTAL CYP	Total number of CYPs produced per month at the facility: Dependent variable 1	158.77 (266.85)	22.03 (45.77)
COST PER CYP	Total cost per CYP at the facility in Dollars: Dependent variable 2	12.90 (8.64)	6.91 (12.55)
POP	Population of Catchment area (DHS in Nigeria and Sub-Pref in Cd'I)	114905 (111331)	5881 (6351)
URBAN	=1 if DHS cluster is urban	0.548 (0.506)	0.485 (0.501)
EDUCATION 1	Percent of women in DHS cluster with a primary education only	0.361 (0.207)	0.266 (0.108)
EDUCATION 2	Percent of women in cluster with a secondary education	--	0.368 (0 .228)
MOTHER AGE	Average age of reproductive age women in the cluster	27.78 (1.89)	28.33 (1.787)
CHILDREN BORN	Mean number of children ever born per woman in the cluster	3.648 (1.006)	2.693 (0.779)
CHILD MORTALITY	Mean child (<5yo) mortality rate in DHS cluster	--	0.028 (0.026)
REFRIG	Percent of households in cluster that have a refrigerator	0.581 (0.316)	0.253 (0.279)
COMPETITION	Inverse of the number of facilities serving DHS cluster	0.645 (0.319)	0.066 (0.041)
PILL PRICE	Price in Dollars of a CYP provided through pills	1.57 (1.39)	1.95 (3.40)
PILL/IUD PRICE RATIO	Ratio of IUD CYP price to pill CYP price		0.169 (0.136)
LAGOS	In Nigerian state of Lagos	--	0.284 (0.452)
ANAMBRA	In Nigerian state of Anambra	--	0.208 (0.407)
KEBBI	In Nigerian state of Kebbi	--	0.053 (0.225)
OSUN	In Nigerian state of Osun	--	0.205 (0.404)
PLATEAU	In Nigerian state of Plateau	--	0.250 (0.434)

Table 3: First Stage Regression Results for Cote d'Ivoire: No fixed effects.
Dependant Variable: Log of Total CYPs

N=31	Model 1	Model 2	Model 3
R^2	0.86	0.88	0.9
CONSTANT	-12.23 (2.29)	-5.990 (3.217)	-4.707 (3.172)
ln(POP)	1.230 (0.206)	0.674 (0.311)	0.588 (0.298)
ln(POP*URBAN)	--	0.139 (0.051)	0.136 (0.049)
ln(POP*EDUCATION 1)	--	0.038 (0.109)	-0.005 (0.105)
ln(POP*EDUCATION 2)	--	-0.008 (0.022)	-0.010 (0.021)
ln(POP*COMPETITION)	0.205 (0.066)	0.175 (0.055)	0.146 (0.065)
ln(POP*AIBEF)	0.097 (0.036)	--	0.075 (0.037)
ln(POP*UNFPA)	0.026 (0.047)	--	-0.006 (0.076)
ln(POP*PILL PRICE)	--	-0.017 (0.075)	-0.022 (0.082)
ln(POP*PILL/IUD RATIO)	--	-0.224 (0.159)	-0.146 (0.212)

Table 4: Second Stage Cost Regression Results for Cote d'Ivoire: No fixed effects. Dependant Variable: Total Cost per CYP

N=31	Model 1	Model 2	Model 3
R^2	0.13	0.13	0.13
CONSTANT	13.001 (5.456)	13.454 (5.344)	12.894 (6.002)
PREDICTED ln(CYP)	0.577 (1.878)	0.491 (2.345)	0.804 (2.794)
URBAN	0.006 (5.397)	-0.372 (8.173)	-1.067 (8.586)
AIBEF	-8.936 (5.409)	-8.295 (4.656)	-9.110 (5.936)
UNFPA	-0.211 (4.195)	-0.460 (4.052)	-0.324 (4.106)

Table 5: Cote d'Ivoire Model Test Statistic Results: No Fixed Effects.

Statistic	Model 1	Model 2	Model 3
Endogeneity Test. T-stat on residuals of first equation in second equation. Coef (S.E.) * sig at .10 ** sig at .05	-0.86 (2.44)	-0.61 (2.45)	-0.92 (2.82)
Over-identify Test. F-stat on excluded variable vector in second equation.	F(2,23) = 0.46 Prob > F = .71	F(6,20) = 1.53 Prob > F = .22	F(8,18) = 1.22 Prob > F = .34
Concentration Parameter	30	21.1	16.6

Output and Average Cost by Operating Authority: Cote d'Ivoire

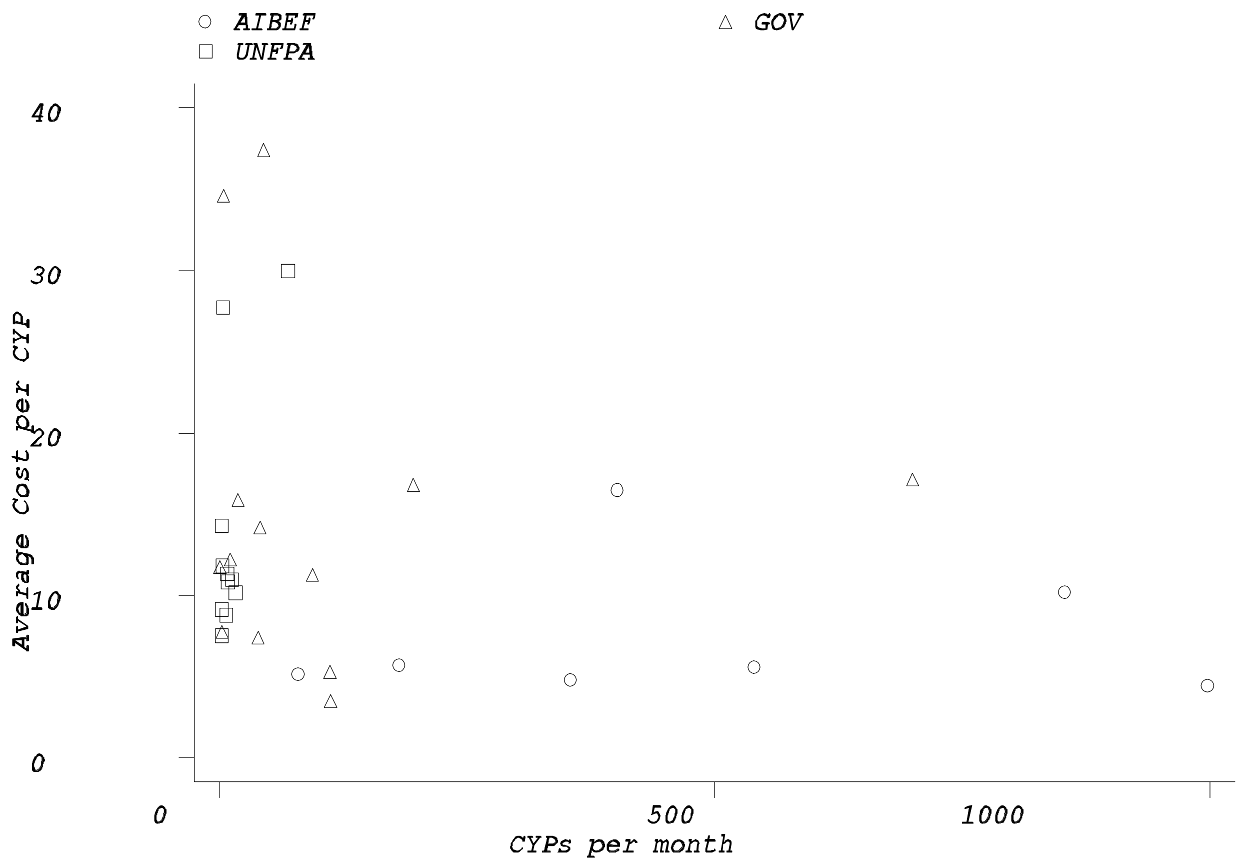

Table 6: Total CYPs Provided in Nigeria by Operating Authority and Structure

Total N=261	N	Total CYPs (se)	
Structure			
VERTICAL	29	66.9	(111.0)
INTEGRATED	232	16.5	(24.5)
Operating Authority			
FEDERAL	9	21.9	(34.5)
STATE	31	30.7	(48.3)
LOCAL	154	15.4	(25.3)
PPFN	3	289.6	(235.1)
PRIVATE	65	21.1	(24.4)
MISSION	1	35	

Table 7: Charged Price per CYP Provided in Nigeria by type of Contraception (In Naira: 82 Naira = $1)

Total N=261	N	Price per CYP	
Oral Contraceptive	261	160.0	(278.5)
Condom	235	114.9	(179.3)
IUD	210	16.3	(19.7)
Spermicide	180	178.8	(365.5)
Injection	234	112.0	(125.2)
Female Sterilization	43	158.2	(245.9)

Table 8: First Stage Regression Results for Nigeria: No fixed effects.
Dependant Variable: Log of Total CYPs

N=261	Model 1		Model 2		Model 3	
R^2	0.44		0.37		0.55	
CONSTANT	3.095	(0.597)	11.246	(1.693)	7.373	(1.638)
ln(POP)	0.063	(0.134)	-0.386	(0.277)	-0.031	(0.266)
ln(POP*URBAN)	--		0.304	(0.057)	0.242	(0.052)
ln(POP*EDUCATION 1)	--		-0.592	(0.103)	-0.435	(0.100)
ln(POP*EDUCATION 2)	--		-0.017	(0.073)	-0.097	(0.065)
ln(POP*CHILD MORTALITY)	--		0.270	(0.265)	0.294	(0.233)
ln(POP*MOTHER AGE)	--		-0.002	(0.009)	-0.009	(0.008)
ln(POP*REFRIG)	--		-0.372	(0.059)	-0.232	(0.055)
ln(POP*CHILDREN BORN)	--		-0.079	(0.022)	-0.033	(0.020)
ln(POP*COMPETITION)	--		-0.957	(0.292)	-1.017	(0.276)
lp(POP*VERTICAL)	0.083	(0.021)	--		0.077	(0.021)
ln(POP*FEDERAL)	0.005	(0.114)	--		-0.052	(0.111)
ln(POP*STATE)	0.028	(0.108)	--		0.020	(0.107)
ln(POP*LOCAL)	-0.016	(0.107)	--		-0.044	(0.107)
ln(POP*PPFN)	0.178	(0.110)	--		0.108	(0.111)
ln(POP*PRIVATE)	-0.018	(0.107)	--		-0.085	(0.102)
ln(POP*PILL PRICE)	--		-0.266	(0.094)	0.139	(0.120)
ln(POP*PILL/IUD RATIO)	--		-0.025	(0.120)	0.022	(0.121)

Table 9: Second Stage Cost Regression Results for Nigeria: No fixed effects.
Dependant Variable: Total Cost per CYP

N=264	Model 1		Model 2		Model 3	
R^2	0.05		0.05		0.06	
CONSTANT	-7.826	(9.929)	1.513	(2.714)	4.286	(3.057)
PREDICTED ln(CYP)	2.405	(2.701)	-0.270	(0.336)	-1.001	(0.490)
URBAN	-1.228	(0.599)	-0.745	(0.433)	-0.639	(0.432)
VERTICAL	-1.575	(1.876)	0.075	(0.565)	0.706	(0.652)
FEDERAL	3.228	(2.752)	3.585	(2.783)	3.331	(2.744)
STATE	0.900	(2.658)	1.584	(2.615)	1.609	(2.589)
LOCAL	2.786	(2.592)	2.590	(2.583)	2.197	(2.551)
PPFN	-2.466	(4.953)	1.726	(2.734)	2.750	(2.749)
PRIVATE	1.583	(2.591)	1.444	(2.580)	1.072	(2.555)

Table 10: Nigeria Model Test Statistic Results: No Fixed Effects.

Statistic	Model 1	Model 2	Model 3
Endogeneity Test. T-stat on residuals of first equation in second equation. Coef (S.E.) * sig at .10 ** sig at .05	-4.50* (2.40)	-0.73** (0.32)	-0.73 (0.48)
Over-identify Test. F-stat on excluded variable vector in second equation.	F(6, 250) = 0.53 Prob > F = .78	F(10, 242) =1.50 Prob > F = .14	F(16,237)=0.99 Prob > F = .47
Concentration Parameter	1.5	82.8	52.8

Table 11: First Stage Regression Results for Nigeria: Fixed effects.
Dependant Variable: Log of Total CYPs

N=261	Model 4		Model 5	
R^2		0.59		0.64
CONSTANT	3.134	(1.987)	7.234	(4.402)
ln(POP)	0.559	(0.305)	-2.258	(0.187)
ln(POP*URBAN)	0.144	(0.055)	0.435	(0.187)
ln(POP*EDUCATION 1)	-0.559	(0.141)	0.059	(0.373)
ln(POP*EDUCATION 2)	-0.282	(0.130)	-0.443	(0.179)
ln(POP*CHILD MORTALITY)	0.179	(0.242)	1.956	(1.705)
ln(POP*MOTHER AGE)	-0.002	(0.008)	0.059	(0.044)
ln(POP*REFRIG)	-0.277	(0.056)	0.153	(0.170)
ln(POP*CHILDREN BORN)	-0.030	(0.020)	-0.094	(0.084)
ln(POP*COMPETITION)	-1.034	(0.278)	-0.312	(0.965)
lp(POP*VERTICAL)	0.062	(0.020)	0.057	(0.022)
ln(POP*FEDERAL)	-0.048	(0.107)	0.001	(0.106)
ln(POP*STATE)	-0.006	(0.103)	0.038	(0.101)
ln(POP*LOCAL)	-0.095	(0.105)	-0.045	(0.103)
ln(POP*PPFN)	0.057	(0.107)	0.117	(0.106)
ln(POP*PRIVATE)	-0.106	(0.099)	-0.063	(0.097)
ln(POP*PILL PRICE)	0.165	(0.119)	0.153	(0.121)
ln(POP*PILL/IUD RATIO)	0.014	(0.130)	0.054	(0.132)
ANAMBRA	-0.877	(0.379)		--
KEBBI	-2.549	(0.866)		--
OSUN	-1.144	(0.304)		--
PLATEAU	-1.227	(0.582)		--
Joint F-Test on FE variables=0 [pvalue]	5.82	[0.000]	3.12	[0.000]

Table 12: Second Stage Cost Regression Results for Nigeria: Fixed effects.
Dependant Variable: Total Cost per CYP

N=261	Model 4		Model 5	
R^2		0.08		0.16
CONSTANT	7.796	(3.531)	13.892	(7.552)
PREDICTED ln(CYP)	-1.521	(0.524)	-5.420	(2.763)
URBAN	-0.145	(1.029)	6.840	(8.055)
VERTICAL	0.527	(0.627)	1.849	(1.300)
FEDERAL	2.360	(2.813)	0.915	(2.972)
STATE	0.752	(2.627)	0.657	(2.719)
LOCAL	0.278	(2.680)	-2.843	(3.247)
PPFN	2.039	(2.725)	4.136	(3.468)
PRIVATE	0.138	(2.615)	-2.708	(3.103)
ANAMBRA	-1.663	(1.220)		--
KEBBI	0.524	(1.549)		--
OSUN	-1.521	(0.785)		--
PLATEAU	0.230	(1.109)		--
Joint F-Test on FE variables=0 [pvalue]	1.54	[0.19]	0.81	[0.73]

Table 13: Model Test Statistic Results: Fixed Effects.

Statistic	Model 4	Model 5
Endogeneity Test. T-stat on residuals of first equation in second equation. Coef (S.E.) * sig at .10 ** sig at .05	-0.35 (0.51)	1.51 (2.51)
Over-identify Test. F-stat on excluded variable vector in second equation.	F(16,233) = 0.75 Prob > F = .74	F(16,218) = 0.78 Prob > F = .71
Concentration Parameter	49.3	1.9

Table 14: Model Test Statistic Results: Fixed Effects in Output Equation Only.

Statistic	Model 4 (modified)	Model 5 (modified)
Endogeneity Test. T-stat on residuals of first equation in second equation. Coef (S.E.) * sig at .10 ** sig at .05	-1.05** (0.42)	-0.85** (0.39)
Over-identify Test. F-stat on excluded variable vector in second equation.	F(20, 233) = 0.95 Prob > F = .53	F(35,218) = 0.84 Prob > F = .73
Concentration Parameter	80.1	120.6

Table 15a: Cost Recovery Ratios (Revenue per CYP divided by Cost per CYP) for Cote d'Ivoire (N=31)

Variable	Median Weighted by Total CYPs Per Facility
AIBEF	0.1181
UNFPA	0.0249
OTHER	0.0827

Table 15b: Cost Recovery Ratios (Revenue per CYP divided by Cost per CYP) for Nigeria (N=261)

Variable	Median Weighted by Total CYPs Per Facility
VERTICAL	0.292
INTEGRATED	0.3033
FEDERAL	0.2633
STATE	0.1989
LOCAL	0.1691
PPFN	0.4458
PRIVATE	1.8963
MISSION	--

Appendix. Variable Construction

CYP measures were constructed using the conversion factors in Table B1 combined with survey data on monthly contraceptive distribution. For example, if the facility hands out three cycles of pills per oral contraceptive visit, they provide 1/5 of a CYP per visitor. Multiplying that by the number of new and returning pill clients yields the total number of CYPs provided through pills for the time period covered by the visits information. We did this for every method offered, using monthly disbursement statistics.

Cost was based on three components: direct labor, contraceptives, and an estimate of equipment use. The data was not adequate to construct an estimate of building cost or incidental overhead expenses, including administration, miscellaneous supplies, utilities etc. Labor and contraceptives are likely to be the largest component of direct provision costs (Evaluation Project 1997, Philippines study).

Labor costs were constructed using the monthly hours and wage rates reported for each type of staff. For vertical facilities where FP is the only output, labor cost per CYP was obtained by dividing monthly staff cost by monthly CYP output. In integrated facilities with multiple outputs, the staff cost had to be allocated between FP and other activities. The allocation was based on the proportion of total monthly patients at the facility that were seen for FP and maternal and child health. This may overestimate the true cost of FP in integrated facilities if other reproductive services require larger amounts of labor than FP services. This is not true according to the scenario analyses conducted with this survey, since FP often requires a physical exam, clinical procedures, and method explanation and disbursement.

Contraceptive cost used the contraceptive distribution records obtained from the survey and prices for the various types of contraceptives obtained from donors (USAID and UNFPA).

This cost includes the cost of shipping the contraceptives to the country, but does not include the logistics cost of in-country storage and distribution.

Equipment cost was calculated by annualizing the value of the equipment stock at the facility. The survey collected an inventory of typical equipment types, which we valued at replacement cost using standard equipment price lists obtained from donor agencies. Equipment was assumed to have a ten-year life, and was converted to a monthly basis by dividing the value of the equipment stock by 120. More sophisticated depreciation techniques did not materially affect this cost. The equipment inventory survey collected data for equipment used exclusively for FP and equipment shared by FP and other activities. All of the FP equipment was allocated to FP cost, and the shared equipment was allocated based on the proportion of FP patients.

Other Variables. The population variable is based on the most recent census for Côte d'Ivoire. For Nigeria the DHS population was obtained from Macro International. Infant and child mortality were directly calculated through the birth history responses in Nigeria. We attempted to correct for both left and right hand censoring of the time period under consideration.

For some variables, the log functional form creates data problems because the log of zero does not exist. If pills are free, we set the pill price at 1 CFA for Côte d'Ivoire. The average pill price was 870 CFAs per year's supply. This only occurs in the UNFPA facilities, which also do not charge for IUDs. For these facilities we set the relative price at 1. The same method was applied to Nigeria where both contraception options were free. In other facilities, if IUDs were not available, the relative price of IUDs to pills was set at 10 in Côte d'Ivoire, an arbitrarily high number. The mean relative price was 1.36 for facilities that offered both methods. The client could still conceivably get the IUD at another facility, but it may be prohibitively expensive and time consuming. The few observations that did not offer IUDs but did offer pills dropped out of the Nigeria analysis. IUDs are the most common and subsidized method in Nigeria, so this was a very small problem.

Table A1: CYP Conversion Factor by Method

Method	Factor
Oral Pills	.0667 CYP per cycle
Condoms (& foaming tables)	.00833 CYP per unit
Injection (Depo-Provera)	.25 CYP per injection
IUD	3.5 CYP per IUD
Sterilization (both male & female)	11 CYP per procedure
Natural FP	2 CYP per trained Individual

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